

Species Diversity, 2007, 12, 237–253

## New Record of Alvinocaridid Shrimps (Crustacea: Decapoda: Caridea) from Hydrothermal Vent Fields on the Southern Mid-Atlantic Ridge, including a New Species of the Genus *Opaepele*

Tomoyuki Komai<sup>1</sup>, Olav Giere<sup>2</sup> and Michel Segonzac<sup>3</sup>

<sup>1</sup>Natural History Museum and Institute, Chiba, 955-2 Aoba-cho, Chuo-ku, Chiba, 260-8682  
Japan

E-mail: komai@chiba-muse.or.jp

<sup>2</sup>Zoological Institute and Zoological Museum, University of Hamburg, Martin-Luther-King-  
Platz 3, D-20146 Hamburg, Germany

E-mail: olav.giere@zoologie.uni-hamburg.de

<sup>3</sup>IFREMER, Centre du Brest, DRO/EP-Centob, F-29280 Plouzané, France

E-mail: michel.segonzac@ifremer.fr

(Received 31 January 2007; Accepted 2 September 2007)

Three species of alvinocaridid shrimps are recorded from the recently discovered hydrothermal vent fields on the southern Mid-Atlantic Ridge: *Opaepele susannae* sp. nov., *Rimicaris exoculata* Williams and Rona, 1986, and *Mirocaris fortunata* (Martin and Christiansen, 1995). All three species are considered to be vent-endemic. The new species is provisionally assigned to the heretofore monotypic genus *Opaepele* Williams and Dobbs, 1995, based on overall similarity. *Opaepele susannae* sp. nov. is primarily distinguished from *O. loihi* Williams and Dobbs, 1995, the type species of the genus, by the dorsally smooth rostrum with a truncate or rounded apex. It is the first representative of *Opaepele* known outside the Pacific Ocean.

**Key Words:** Crustacea, Decapoda, Caridea, Alvinocarididae, *Opaepele*, new species, new record, southern Mid-Atlantic Ridge, hydrothermal vent.

### Introduction

Hydrothermal vents and other reducing habitats in deep water (e.g., brine, cold-water sulfide, and hydrocarbon seeps) are frequently inhabited by shrimps of the caridean family Alvinocarididae. Most species appear to be restricted to a particular ridge, seamount, or seep system, although a few species have broad, disjunct distributions (Webber 2004; Komai and Segonzac 2005). Recent studies have reported new species from various localities in the world oceans (Kikuchi and Hashimoto 2000; Watabe and Hashimoto 2002; Shank and Martin 2003; Komai and Segonzac 2004, 2005; Martin and Shank 2005; Komai *et al.* 2005, 2006; see also the review by Martin and Haney 2005), and the family is, so far, represented by 19 species in seven genera. Phylogenetic relationships among some species were investigated by Shank *et al.* (1999) on the basis of an analysis of the mitochondrial Cytochrome C Oxidase subunit I (COI) gene.

During recent surveys conducted from RV *Meteor* (M 64/1, April 2005, chief scientist Dr K. Haase; and M 68/1, May 2006, chief scientist Prof. Dr A. Koschinsky),

newly discovered vent sites on the southern Mid-Atlantic Ridge were investigated (Koschinsky *et al.* 2006; Haase *et al.* in press) (Fig. 1). These sites consist of hot black smokers and diffuse venting fields. In this paper, we report (1) a new species of the Alvinocarididae on the basis of five specimens and (2) new locality records for *Rimicaris exoculata* Williams and Rona, 1986 and *Mirocaris fortunata* (Martin and Christiansen, 1995). The new species, which represents the sixth alvinocaridid species known from hydrothermal vents on the Mid-Atlantic Ridge, is provisionally assigned to *Opaepele* Williams and Dobbs, 1995 on the basis of overall similarity, although the characters of the rostrum suggest a closer relationship to *Chorocaris* Martin and Hessler, 1990 and *Rimicaris* Williams and Rona, 1986. The generic diagnosis of *Opaepele* is slightly emended in order to accommodate the new species.

### Materials and Methods

The specimens studied came from two German cruises on the southern Mid-Atlantic Ridge (SMAR) conducted aboard RV *Meteor* (Fig. 1): M 64/1, April 2005, ROV *Quest 4000*, site Turtle Pits (04°48.57'S, 12°22.41'W, 2998 m) (Haase *et al.* in press); and M 68/1, May 2006, ROV *Quest 4000*, sites Sisters Peak (04°48.188'S, 12°22.301'W, 2986 m), Mephisto (04°47.834'S, 12°22.593'W, 3045 m), and Lilliput (09°32.845'S, 13°12.546'W, 1500 m) (Koschinsky *et al.* 2006). They are deposited in the Zoologisches Institut und Zoologisches Museum, Hamburg, Germany (ZMH). The terminology used in the description follows that of Komai and Segonzac (2003, 2005). Polarity of characters is preliminarily assessed by outgroup comparison using species of *Bresilia* Calman, 1896 (cf. Komai and Segonzac 2003).

For comparison, paratypes of *Opaepele loihi* Williams and Dobbs, 1995 in the collection of the National Museum of Natural History, Smithsonian Institution,

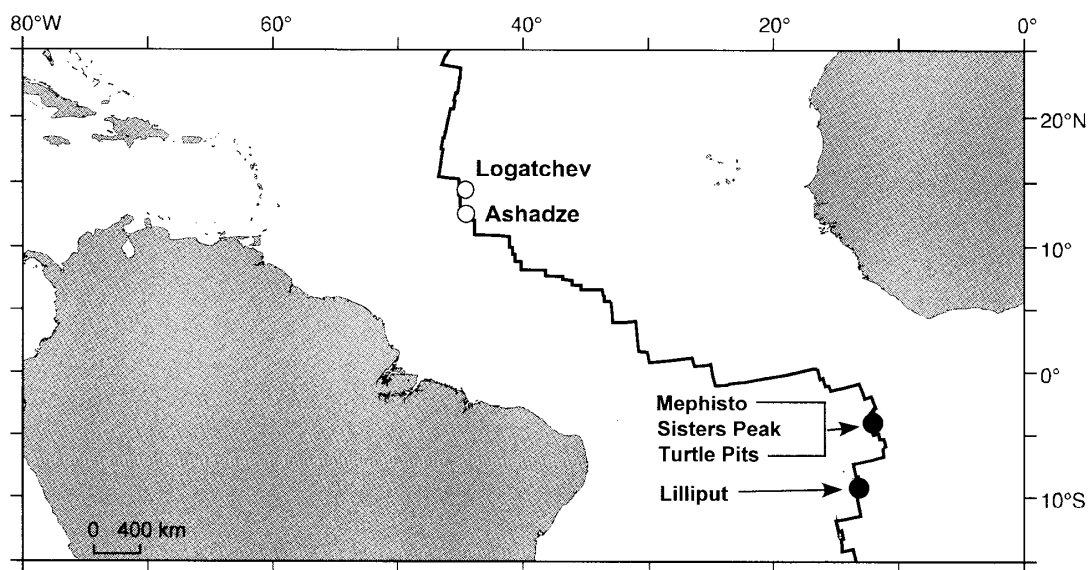


Fig. 1. Map of the Central Atlantic Ocean showing hydrothermal sites and sampling locations (closed circles).

Washington, D.C. (USNM), were examined: USNM 251449, 2 males (CL 6.8, 8.9 mm), 2 females (CL 9.2, 9.4 mm), DSRV *Pisces V*, dive #213, Hawaii, Loihi Seamount, 18°55'N, 144°42.431'E, 980 m, 28 August 1992, baited trap.

### Taxonomic Account

Genus *Opaepele* Williams and Dobbs, 1995

*Opaepele* Williams and Dobbs, 1995: 229; Martin and Haney 2005: 467.

**Type species.** *Opaepele loihi* Williams and Dobbs, 1995.

**Emended diagnosis.** Alvinocarididae as defined by Komai and Segonzac (2003). Rostrum carinate or non-carinate, triangular with acute or blunt tip in dorsal view; dorsal margin in lateral profile sweeping obliquely downward from most elevated point of carapace to tip, toothless or minutely dentate; ventral surface slightly elevated in midline, toothless; lateral margins diverging posteriorly to merge with orbital margins. Carapace moderately compressed laterally, with antennal and pterygostomial teeth, former acute or subacute. Telson with dorsolateral spines arranged in sinuous row on either side. Eye-stalks rather large, but degenerate, broadly fused mesially, without tubercles on anterior surface. Antennular peduncle with stylocerite clearly separated from first segment by narrow hiatus; first segment with distolateral and distomesial teeth and with conspicuous tubercle on dorsal surface proximal to base of stylocerite; second segment with distomesial tooth. Antennal basicerite not fully covered by pterygostomial angle of carapace; antennal scale oval, non-operculate, distal lamella far exceeding small distolateral tooth. Maxilla without facial setae on scaphognathite; posterior lobe of scaphognathite somewhat elongate. First maxilliped with rudimentary bud of flagellum of exopod; no facial setae on exopod. Second maxilliped with simple podobranch. Epipod of third maxilliped bilobed, lacking strap-like process. Pereopods without strap-like epipods. Carpus of first pereopod with grooming apparatus on mesial face. Second pereopod unarmed on ischium. Ischia and meri of third to fifth pereopods unarmed; propodi each with 2 rows of corneous spinules on flexor surface; dactyli short, each with accessory spinules on flexor surface, arranged in 2 longitudinal rows. Gill formula summarized in Table 1. Appendices

Table 1. Gill formula of *Opaepele*.

Thoracic somites	1	2	3	4	5	6	7	8
	Maxillipeds					Pereopods		
	1	2	3	1	2	3	4	5
Pleurobranchs	—	—	—	1	1	1	1	1
Arthrobranchs	—	—	1	1	1	1	1	—
Podobranchs	—	r	—	—	—	—	—	—
Epipods	1	1	1	—	—	—	—	—
Exopods	1	—	—	—	—	—	—	—
Setobranchs	—	—	—	—	—	—	—	—

Abbreviation: r, rudimentary.

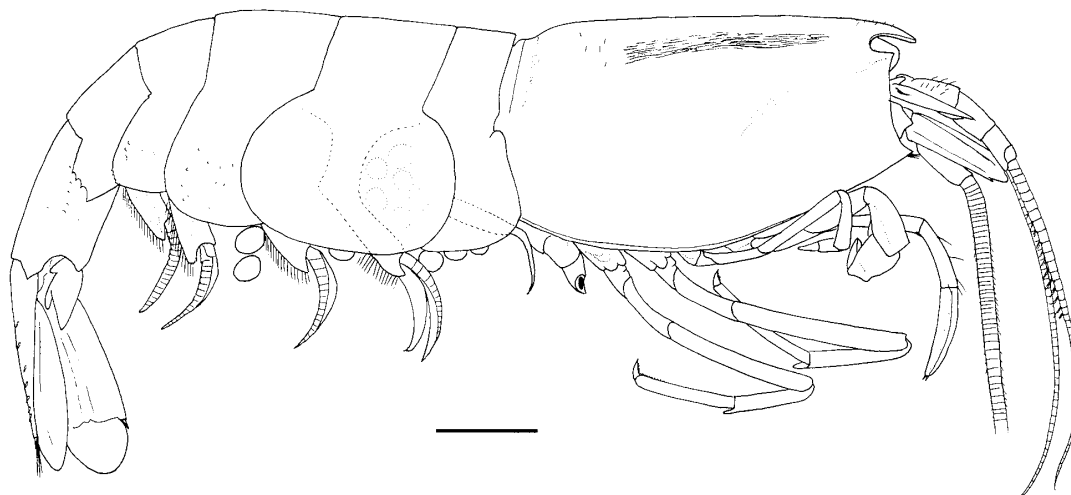


Fig. 2. *Opaepele susannae* sp. nov., holotype, ovigerous female (CL 7.5 mm), ZMH K-41455, Lilliput, southern Mid-Atlantic Ridge, habitus in lateral view (fifth pereopod detached). Scale bar: 2 mm.

internae on second to fourth pleopods short, simple, that on fifth pleopod normally developed, with cluster of adhesive hooks.

***Opaepele susannae* sp. nov.**

(Figs 2–7)

**Type material.** Holotype: ZMH K-41455, ovigerous female (CL 7.5 mm), RV *Meteor*, M68/1 cruise, stn 41 ROV-2, ROV *Quest 4000*, Lilliput, southern Mid-Atlantic Ridge, 09°32.845'S, 13°12.546'W, 1500 m, mussel field with diffuse vent fluids, 19 May 2006. Paratypes: ZMH K-41456, 2 females (CL 5.4, 6.8 mm), same data as holotype; ZMH K-41457, 1 male (CL 4.6 mm) and 1 female (CL 4.8 mm), RV *Meteor*, M68/1 cruise, stn 20 ROV-1, ROV *Quest 4000*, Sisters Peak, 04°48.188'S, 12°22.301'W, 2986 m, wall of hot smoker, 14 May 2006.

**Description of holotype.** Body (Fig. 2) moderately robust. Integument thin, but not membranous; surface generally smooth.

Rostrum (Fig. 3A, B) subtriangular, subtruncate terminally, flattened dorso-ventrally, short, overreaching antennal teeth, slightly directed ventrally; neither dorsal nor ventral surface dentate. Carapace (Figs 2, 3A–C) moderately compressed laterally, with sparse short setae along midline (including rostrum), occurring in greater density in anterior part; cuticle surface apparently smooth even under high magnification (about  $\times 40$ ). Dorsal midline slightly elevated as blunt postrostral ridge, and dorsolateral parts to either side of postrostral ridge shallowly depressed and ornamented by fine longitudinal striae. Orbital margin evenly concave; antennal tooth acuminate, directed mesially; pterygostomial tooth exceeding antennal tooth. Anterolateral margin between antennal tooth and pterygostomial tooth slightly concave. Shallow post-antennal sulcus present. Posterior submarginal groove shallow.

Paired submedian spines on seventh somite slender; median spur on eighth

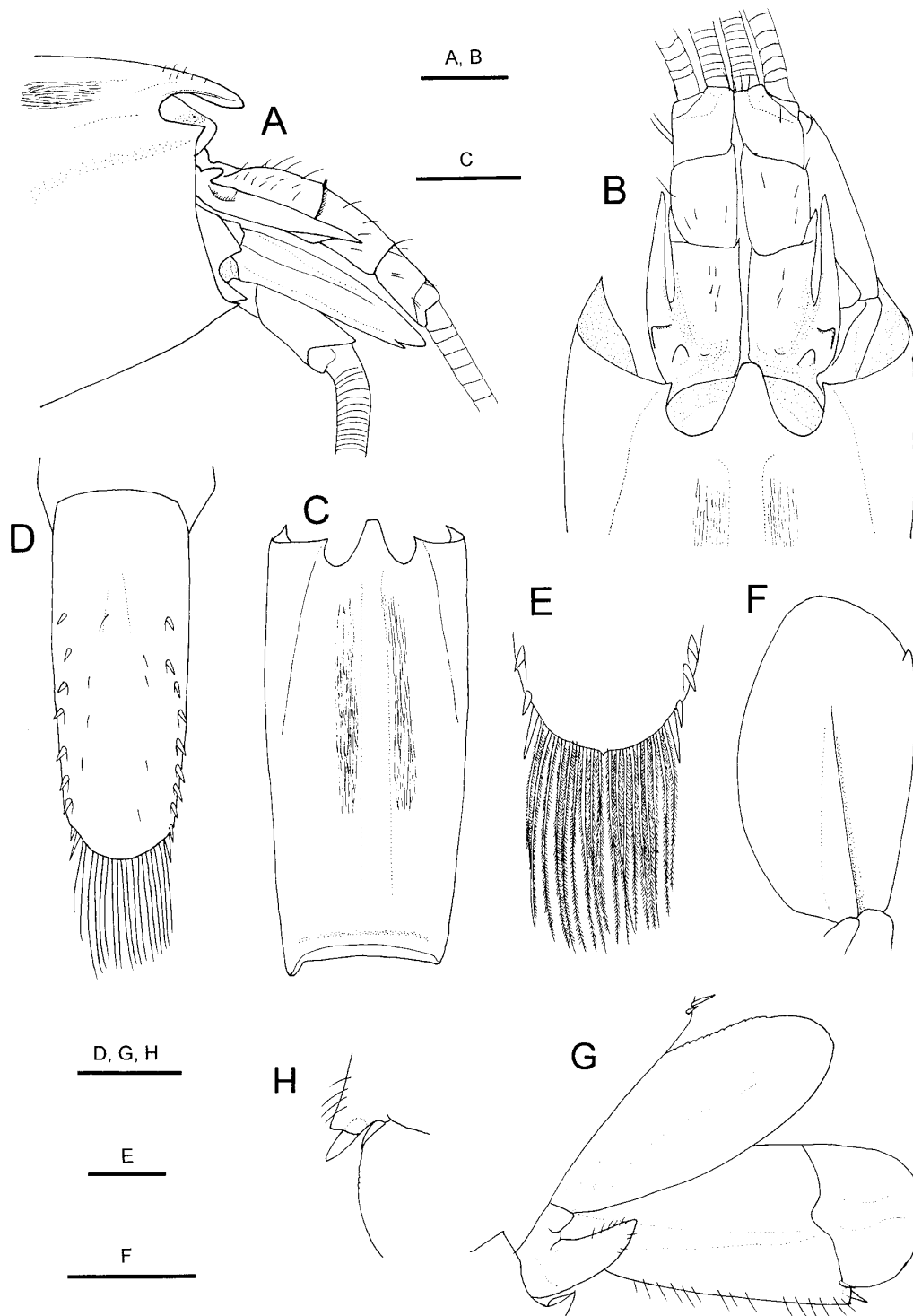


Fig. 3. *Opaepele susannae* sp. nov., holotype, ovigerous female (CL 7.5 mm), ZMH K-41455, Lilliput, southern Mid-Atlantic Ridge. A, Anterior part of carapace and cephalic appendages, lateral view; B, same, dorsal view (left antenna missing); C, carapace, dorsal view; D, telson, dorsal view; E, posterior part of telson, dorsal view; F, right antennal scale, dorsal view; G, left uropod, dorsal view; H, posterolateral part of uropodal exopod, dorsal view. Scale bars: 2 mm for C; 1 mm for A, B, D, F, G; 0.5 mm for E, H.

somite blunt.

Pleon (Fig. 2) rounded dorsally, without armature or carination; pleura of anterior three somites all broadly rounded; fourth pleuron minutely dentate posterolaterally; fifth pleuron with acute posteroventral tooth and additional row of small teeth on posterolateral margin. Sixth somite about 1.5 times longer than fifth somite, 1.9 times longer than high; posterolateral process short, terminating in small, acute tooth; posteroventral corner produced, terminating in subacute tooth. First pleonal sternite with pair of small submedian spines; similar spines better developed and more strongly curved mesially on second and third sternites, less well developed on fourth sternite. Fifth sternite with distinct median keel terminating posteriorly in acute spine. Sixth sternite flattened, thin, transparent, with small preanal spine.

Telson (Fig. 3D) 1.3 times as long as sixth pleonal somite, 2.7 times longer than wide, slightly narrowed posteriorly, width between posterolateral corners about 0.7 of anterior width; posterior four-fifths of dorsal surface bearing sinuous row of spines on either side, 7 (left) or 8 (right) (excluding spines at posterolateral corner); posterior margin (Fig. 3E) convex, bearing 2 pairs of posterolateral spines (mesial spine much longer than lateral spine) and 18 long, plumose setae.

Corneal region with brown pigmentation visible inside.

Antennular peduncle (Fig. 3A, B) stout, slightly flattened dorsoventrally. First segment with distal width nearly half its length; dorsal surface convex in distal part, but proximal part somewhat depressed below, this depression continuous with deep groove separating basal segment and stylocerite; distal margin slightly oblique in dorsal view; distolateral tooth reaching nearly to midlength of second segment, overlapped by stylocerite, distomesial tooth much smaller than distolateral tooth; ventromesial ridge with 1 spinule arising at about midlength of segment; stylocerite overreaching midlength of second peduncular segment. Second segment with scattered short setae on dorsal surface; distomesial tooth larger than corresponding tooth on first segment. Third segment wider than long. Flagella (Fig. 2) unequal, inserted side by side on oblique terminal margin of third segment; lateral flagellum shorter than mesial one, proximal aesthetasc-bearing portion occupying about 0.6 of total length of flagellum; mesial flagellum with annuli much denser than those on lateral flagellum.

Antenna (Fig. 3A, B) with basicerite stout, bearing acute ventrolateral distal tooth; small tooth present on ventral surface of basicerite (not shown in Fig. 3A). Carpocerite (fifth segment of antennal peduncle) stout, cylindrical, exceeding midlength of scaphocerite. Antennal scale (Fig. 3F) broadly oval with greatest width at midlength, about 1.8 times longer than wide, about 0.3 times as long as carapace; lateral margin slightly convex, terminating in small distolateral tooth; strongly produced, rounded lamella considerably exceeding distolateral tooth; dorsal surface with distinct median ridge somewhat diverging against lateral margin. Flagellum stouter than antennular flagella, slightly longer than body, annuli dense.

Mouthparts typical of alvinocaridids. Mandible (Fig. 4A) with incisor process broad, bearing 6 unequal acute or subacute teeth on mesial margin (distalmost tooth distinctly separated from remaining teeth); molar process slender, unarmed, not reaching as far as incisor process; basal article of palp nearly straight; distal article stout, shorter than basal article, bearing numerous plumose setae of differing lengths. Maxillule (Fig. 4B) with coxal endite tapering distally, with dense, stiff

setae on mesial margin; basal endite moderately broad, its mesial margin with 2 rows of small spines obscured by stiff submarginal setae; palp weakly curved, slightly bilobed distally; outer lobe with short simple seta, inner lobe with long plumose seta. Maxilla (Fig. 4C) with coxal endite consisting of single narrow lobe; basal endite divided into 2 unequal lobes each bearing dense marginal setae; proximal lobe subrectangular, distal lobe subtriangular; endopod slender, weakly curved, overreaching distal lobe of basal endite; scaphognathite moderately broad, its anterior lobe subovate with densely setose margin bearing longest setae along distomesial sector, its posterior lobe elongate subtriangular, fringed on mesial to terminal margins with setae becoming longer posteriorly. First maxilliped (Fig. 4D) with coxal endite somewhat thickened, with numerous setae on mesial face; basal endite moderately broad, with dense setae on slightly concave mesial margin; endopod only partially visible in ventral view (see Fig. 4E), slender, simple, slightly curved mesially; exopod broadly expanded, fringed with double row of long plumose setae, small mesial lobe representing reduced flagellum evident (Fig. 4E); epipod moderately large, faintly bilobed. Second maxilliped (Fig. 4F) with endopod moderately stout; coxa expanded mesially, with numerous setae on mesial margin; basis and ischium completely fused, this fused segment longest, with row of dorsally curved setae on mesial margin forming basket-like structure; merus about half length of basis-ischium fused segment, with long plumose setae on lateral face; carpus short, with long plumose setae on outer surface; propodus lacking marginal rows of setae; articulation between propodus and dactylus oblique; dactylus longer than propodus, tapering to blunt apex, bearing dense cluster of short setae on mesial to distal margins; epipod triangular, with slender rudiment of podobranch overreaching midlength of basis-ischium fused segment.

Third maxilliped (Fig. 5A) overreaching anterior margin of scaphocerite by length of ultimate segment. Coxa stout; epipod large, bilobed in dorsal view. Antepenultimate segment (basis-ischium-merus fused segment, but fusion between basis and ischium incomplete with suture on ventral surface) somewhat flattened dorsoventrally, sinuously curved in dorsal view, setose, with slender spine at distolateral ventral angle; tuft of long setae at proximomesial portion and cluster of short, stiff setae on ventromesial margin distal to midlength (Fig. 6A). Penultimate segment (carpus) with dense setae on mesial surface. Ultimate segment about 1.4 times longer than carpus, gradually tapering distally to subtruncate tip, with 3 terminal spines.

First pereopod (Fig. 5B) reaching (when extended) distal margin of antennal scale, with chela and carpus oriented toward midline. Ischium and merus slender, articulation between them strongly oblique. Merus somewhat compressed laterally, ventral surface slightly concave for reception of flexed carpus. Carpus shorter than merus, irregularly funnel-shaped, dorsal surface bent at right angle near tapered proximal end articulating with merus; distomesial margin concave to accommodate proximal part of palm; mesial face (Fig. 6D) concave, with grooming apparatus consisting of patch of stiff setae and 1 spinule placed proximal to setal patch. Chela typical of alvinocaridids. Palm (Fig. 6B) short, inflated, lacking patch of short setae on mesial surface ventrally. Fingers curved and closing without gap, about twice length of palm; flexor surface concave; extensor surface of each finger convex, without prominent submarginal row of stiff setae; cutting edges uniformly offset, each armed with row of uniform, minute, erect, closely set setae; acute tip of

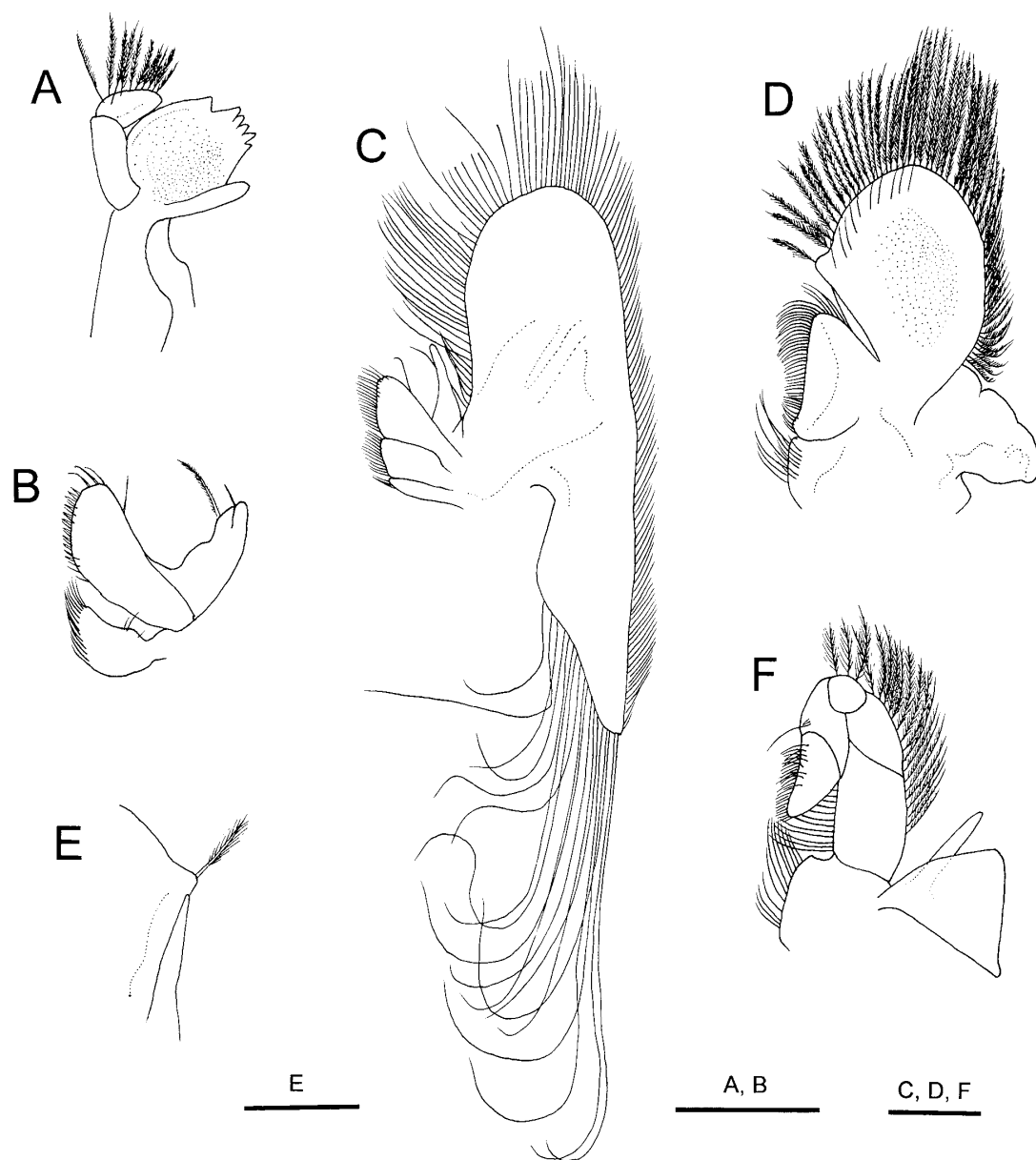


Fig. 4. *Opaepele susannae* sp. nov., holotype, ovigerous female (CL 7.5 mm), ZMH K-41455, Lilliput, southern Mid-Atlantic Ridge, left mouthparts. A, Mandible, inner view; B, maxillule, outer view; C, maxilla, outer view (setules on marginal setae on scaphognathite omitted); D, first maxilliped, outer view; E, first maxilliped, lobe representing reduced flagellum, inner view; F, second maxilliped, outer view. Scale bars: 0.5 mm.

each finger spooned by curved setal row, that of dactylus with elongate spiniform setae slanting distad and curving around its distal end; line of sensory setae mesial to each cutting edge. Dactylus uniformly narrowed distally, considerably flattened in distal half; external surface without conspicuous rows of setae along cutting edge.

Second pereopod (Fig. 5C) thinner than other pereopods, falling short of distal



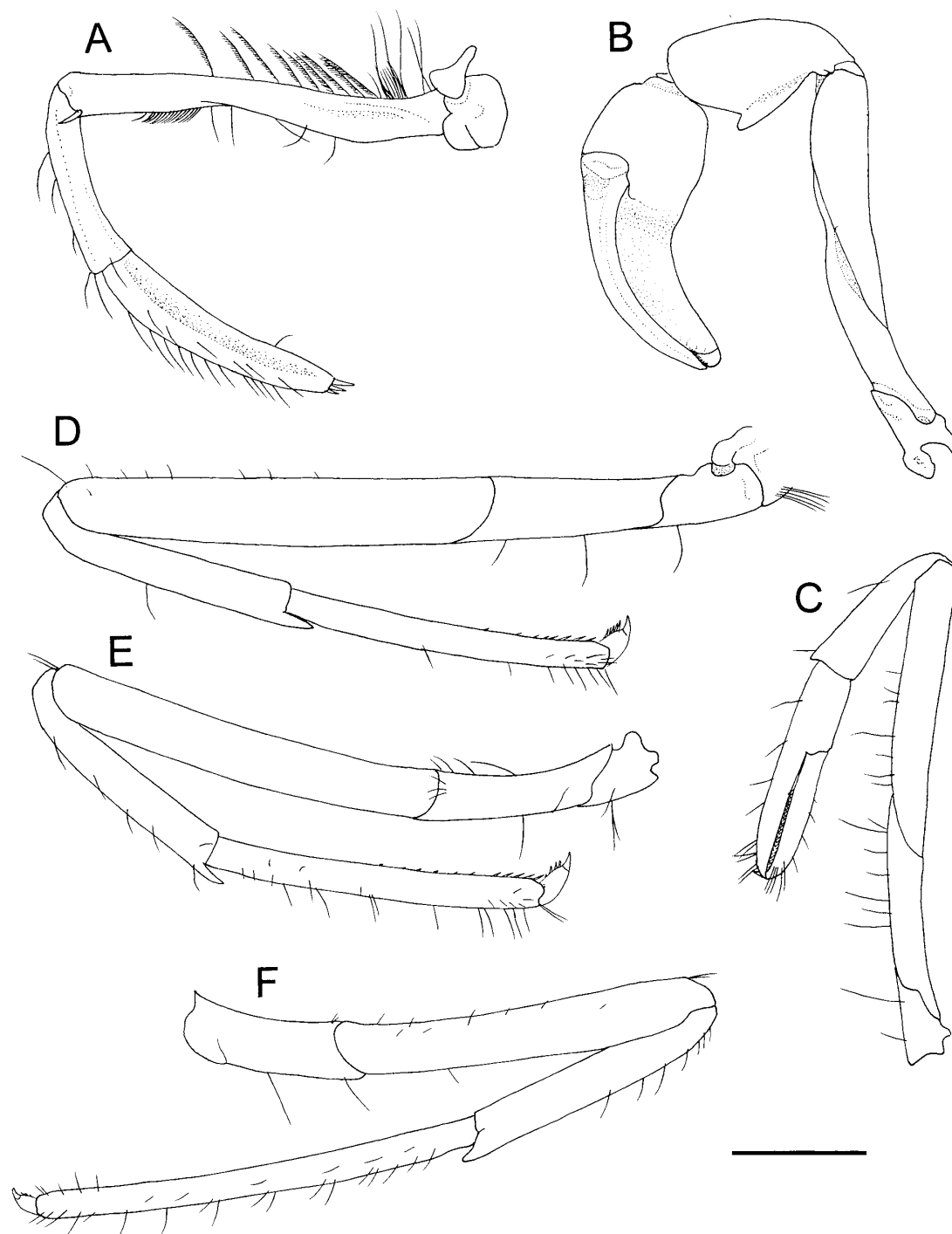


Fig. 5. *Opaepele susannae* sp. nov., holotype, ovigerous female (CL 7.5 mm), ZMH K-41455, Liliiput, southern Mid-Atlantic Ridge. A, Left third maxilliped, lateral view; B, left first pereopod, lateral view; C, left second pereopod, lateral view; D, left third pereopod, lateral view; E, left fourth pereopod, lateral view; F, right fifth pereopod, lateral view. Scale bar: 1 mm.

margin of antennal scale. Articulation between ischium and merus oblique. Ischium unarmed. Sparse setae present on ventral margin of ischium to merus. Carpus widened distally, with dorsodistal margin slightly produced. Chela (Fig. 6E) about 1.4 times length of carpus, about 4.9 times longer than wide; fingers each terminating in small corneous claw, crossing at tips; external surfaces slightly depressed toward cutting edges, with scattered very short setae and longer setae on distal parts of fingers; cutting edges pectinate with row of closely set corneous spinules. Dactylus 2.0 times as long as palm.

Third to fifth pereopods generally similar in structure, but increasing in length from anterior pair to posterior pair. Third pereopod (Fig. 5D) overreaching distal margin of antennal scale by almost entire length of propodus; ischium and merus unarmed, merus about 6.4 times longer than high; carpus-propodus combined slightly shorter than merus-ischium combined; carpus about 0.8 times as long as propodus; propodus (Fig. 6H) with 2 rows of spinules on flexor surface; dactylus (Fig. 6F, G) stout, 0.2 times as long as propodus (including unguis), flexor surface with 6 accessory spinules arranged in 2 rows, spinules becoming larger distally; unguis elongate, clearly demarcated. Fourth pereopod (Fig. 5E) overreaching antennal scale by length of dactylus; ischium and merus unarmed; carpus-propodus combined subequal in length to merus-ischium combined. Fifth pereopod (Fig. 5F) reaching distal margin of antennal scale; ischium and merus unarmed; carpus-propodus combined distinctly longer than merus-ischium combined; flexor surface of propodus (Fig. 6I) with 2 rows of spinules, spinules in mesial row much more numerous than in lateral row, distal spinules setulose.

Pleurobranchs on fourth to eighth thoracic somites asymmetrically Y-branched, noticeably increasing in length posteriorly, apices directed forward. Arthrobranchs on third to seventh thoracic somites moderately developed, nearly symmetrically U-branched; last arthrobranch on seventh somite distinctly smaller than those preceding. No strap-like epipods and corresponding setobranchs present on pereopods.

Endopod of first pleopod uniformly tapering with margins fringed sparsely with plumose setae; second to fourth pleopods each with short, slender appendix interna lacking adhesive hooks; fifth pleopod with normally developed appendix interna with cluster of adhesive hooks.

Uropod (Fig. 3G) with protopod terminating subacutely; both rami elongate oval, exceeding posterior margin of telson; endopod shorter and narrower than exopod; exopod with straight lateral margin terminating in small, truncate projection (Fig. 3H); 2 small posterolateral spines present (Fig. 3H); suture distinct, with median notch.

**Description of paratype.** The paratypes consist of one male and three females. They are generally similar to the holotype, and differences are noted below.

Rostrum (Fig. 7A–C) rounded or subtruncate distally, overreaching antennal teeth by 0.2–0.3 of its length. Carapace lacking postrostral ridge and dorsolateral depressions (Fig. 7A–C); antennal teeth acute or subacute; post-antennal sulcus well delineated in largest female, less conspicuous in other specimens; pterygostomial angle less produced than in holotype, but terminating in small, acute tooth; anterolateral margin between antennal and pterygostomial teeth nearly straight or sinuous.

Armament of fourth and fifth pleonal pleura variable individually (Fig. 7D, E).

Telson with 5–7 dorsolateral spines on either side; posterior margin with about 16 plumose setae.

Chela of first pereopod (Fig. 6C) less stout than in holotype; fixed finger slightly deflexed; dactylus about 4.0 times longer than palm. Dactyli of third to fifth pereopods each with 5 or 6 accessory spinules arranged in 2 rows.

Endopod of male first pleopod (Fig. 6J) bilobed terminally; mesial lobe prominent, rounded distally, spiniform setae apparently broken off; lateral lobe obsolete. Second pleopod of male with short, distally tapering appendix masculina (Fig. 6K), bearing 3 spiniform setae distally; appendix interna slender, subequal in length to appendix masculina.

**Coloration.** In freshly retrieved specimens dorsal carapace bright red with large, white eye-stalks. Lateral and caudal parts as well as appendages opaque-whitish (transparent when alive).

**Variation.** As is apparent from the above description, the new species exhibits substantial variation in the structure of the carapace, armament of the fourth and fifth pleonal pleura, and the shape of the chela of the first pereopod. The differentiation of the postrostral ridge and accompanying dorsolateral depressions ornamented with fine longitudinal striae appears to be a characteristic of spawning females, because a similar modification is also seen in other alvinocaridid species of which ovigerous females are known, i.e., *Mirocaris fortunata*, *Chorocaris vandoverae* Martin and Hessler, 1990, and *C. paulexa* Martin and Shank, 2005 (Komai and Segonzac 2003; Martin and Shank 2005; personal observation).

**Distribution.** So far known only from the Sisters Peak (2986 m) and Lilliput (1500 m) sites on the southern Mid-Atlantic Ridge.

**Habitat.** Two specimens of *Opaepele susannae* sp. nov. were collected on the lower walls of Sisters Peak, a 12 m high black smoker emitting a fluid of 399°C. Here, the shrimp assemblage was dominated by dense aggregations of *Rimicaris exoculata*. At the base of the black smoker, patches of deep-sea mussels (*Bathymodiolus puteoserpentis* Cosel, Métivier and Hashimoto, 1994) colonized the crevices; some bythograeid crabs (probably *Segonzacia mesatlantica* (Williams, 1988)) and turrid gastropods (*Phymorhynchus* sp.; A. Warén, pers. comm.) were found. A similar faunal assemblage was sampled from the wall of Turtle Pits, another black smoker (Giere, personal observation).

Three specimens of *Opaepele susannae* came from rich mussel beds at the Lilliput vent field, from washings of a thicket of byssus threads of *B. puteoserpentis*. This site was characterized by diffuse venting outlets (about 3.5–4.0°C) in a field of large lava boulders covered with a red-orange layer of iron oxide deposits. Scattered between the lava blocks were numerous mussel patches consisting exclusively of juvenile mussels. The size-frequency distribution of these mussels indicates a recent onset of venting activity as a settling cue for competent mussel larvae. A rich assemblage of polychaetes, pycnogonids, and cyclopoid copepods co-occurred with the shrimps.

**Etymology.** Named after the daughter of the second author, Susanne Giere, whose fervent dream is to become taxonomically eternalized in a marine creature.

**Remarks.** Based on a molecular analysis using a short sequence of the mtCOI gene (600 bp), Shank *et al.* (1999) proposed a phylogenetic tree of alvinocaridids including the five genera recognized at that time. The proposed relationship is: (*Mirocaris* (*Alvinocaris* (*Opaepele* (*Chorocaris vandoverae* (*Chorocaris chacei*+

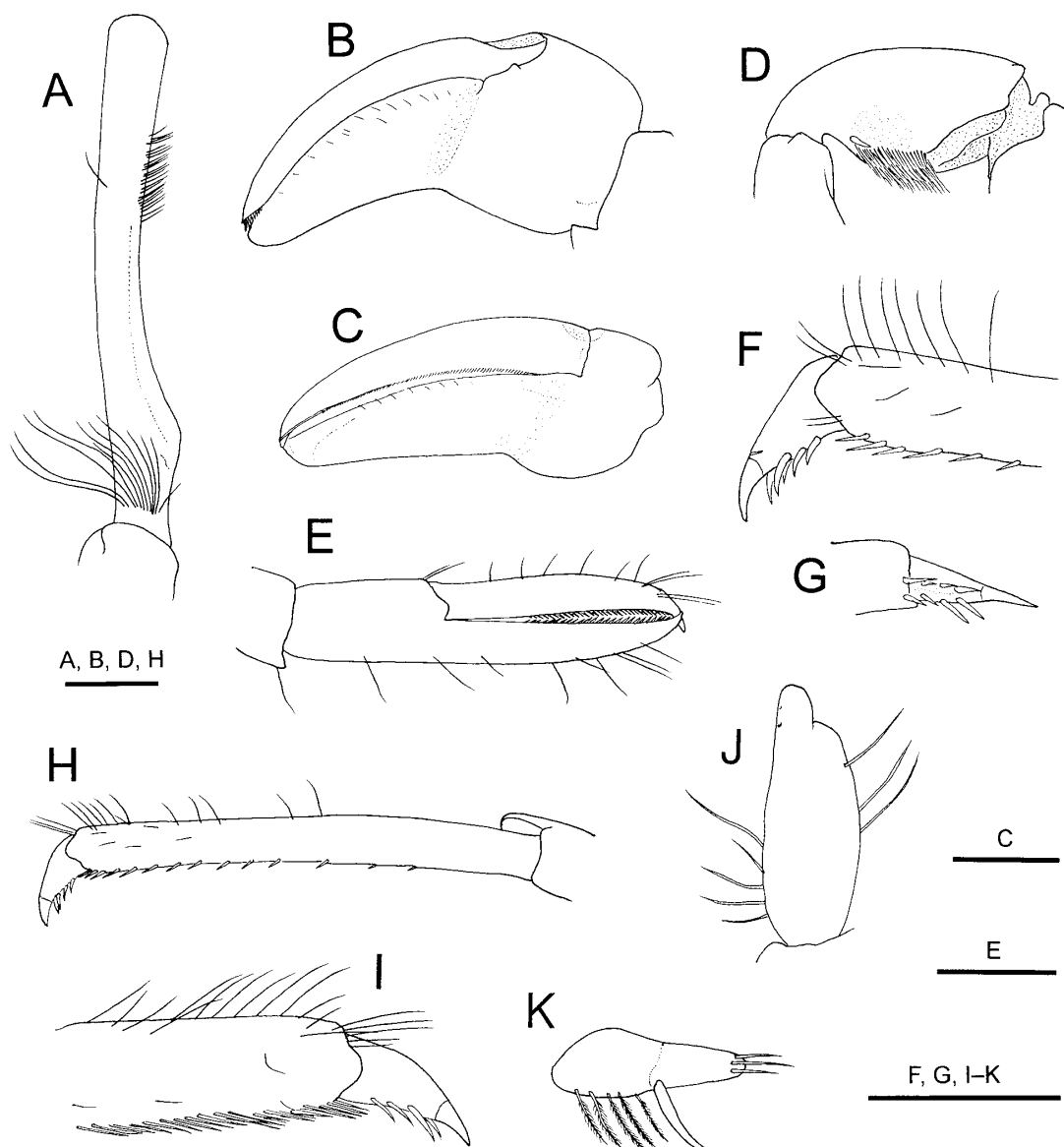


Fig. 6. *Opaepele susannae* sp. nov. A, B, D–I, Holotype, ovigerous female (CL 7.5 mm), ZMH K-41455, Lilliput, southern Mid-Atlantic Ridge; C, J, K, paratype, male (CL 4.6 mm), ZMH K-41457, Sisters Peak, southern Mid-Atlantic Ridge. A, Antepenultimate segment of left third maxilliped, dorsal view (setae partially omitted); B, C, chela of left first pereopod, ventrolateral view; D, carpus of left first pereopod, mesial view; E, chela of left second pereopod, lateral view; F, dactylus and distal part of propodus of left third pereopod, lateral view; G, dactylus of left third pereopod, ventral view; H, dactylus and propodus of left third pereopod, lateral view; I, dactylus and distal part of propodus of right fifth pereopod, lateral view; J, endopod of left first pleopod, ventral view; K, appendices interna and masculina of left second pleopod, mesial view. Scale bars: 0.5 mm.

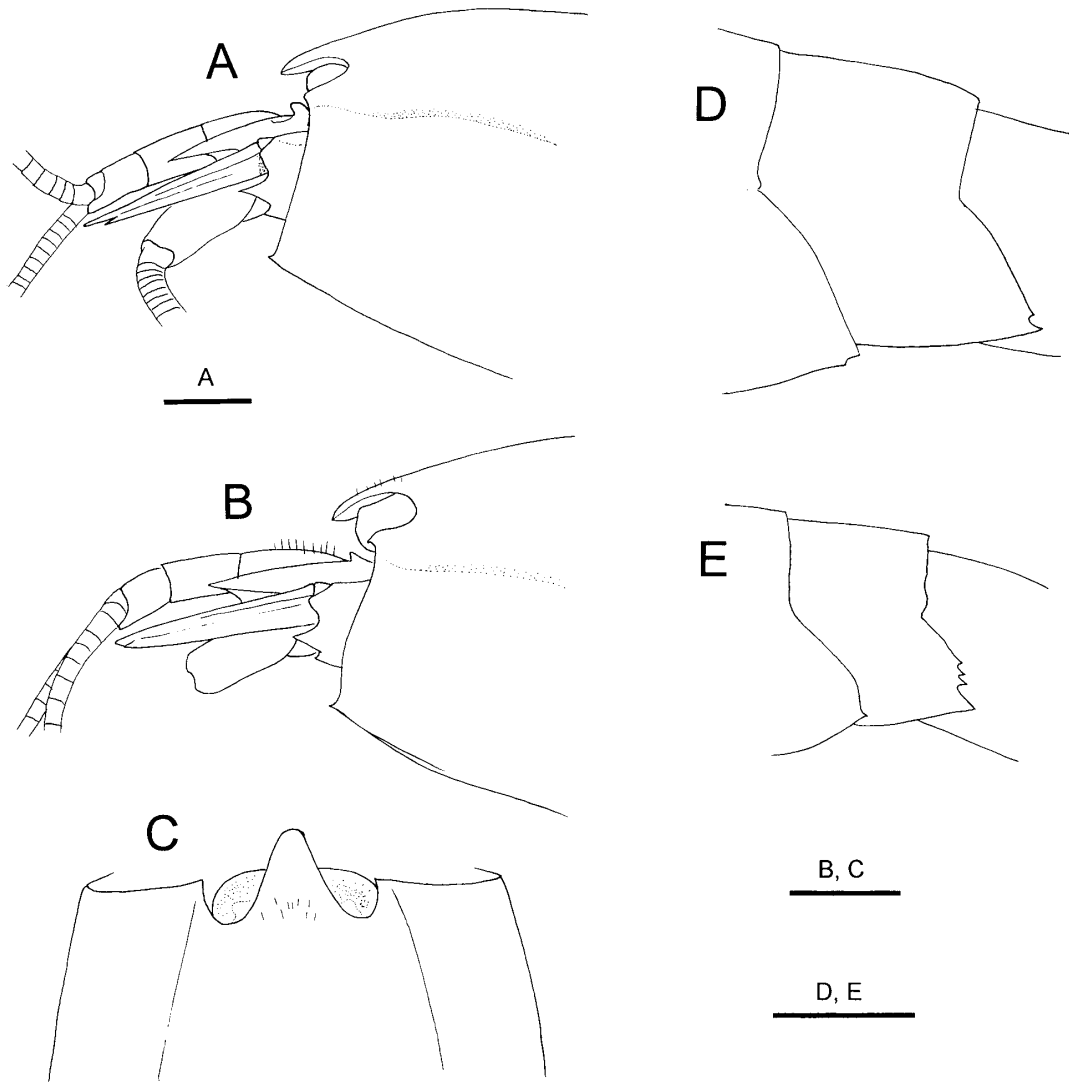


Fig. 7. *Opaepele susannae* sp. nov. A, D, Paratype, female (CL 6.8 mm), ZMH K-41456, Lilliput, southern Mid-Atlantic Ridge; B, C, E, paratype, female (CL 4.8 mm), ZMHK-41457, Sisters Peak, southern Mid-Atlantic Ridge. A, B, Anterior part of carapace and cephalic appendages, lateral view; C, anterior part of carapace and ocular appendage, dorsal view; D, E, pleura of fourth and fifth pleonal somites, lateral view. Scale bars: 1 mm.

*Rimicaris exoculata*))))). Since then, two new genera have been described (Komai and Segonzac 2004, 2005). Komai and Segonzac (2004) indicated that *Nautilocaris* is closely related to *Mirocaris*. *Alvinocaris leurokolos* Kikuchi and Hashimoto, 2000 was transferred to a newly established genus *Shinkaicaris* by Komai and Segonzac (2005), because certain synapomorphic characters suggest a closer relationship of that species to a clade including *Opaepele*, *Chorocaris*, and *Rimicaris*. The new taxon described herein can be placed in a group of genera, including *Shinkaicaris*, *Opaepele*, *Chorocaris*, and *Rimicaris*, that is characterized by two presumably apomorphic characters, viz., the unarmed ischia and meri of the third to fifth pereopods in adults and the multiserial arrangement of the accessory spinules on the

flexor surfaces of the dactyli of the third to fifth pereopods. The present new species appears intermediate between *Opaepele* and the clade including species of *Chorocaris* and *Rimicaris*. A trend toward a reduction of the rostrum is considered to be apomorphic in the Alvinocarididae based on an outgroup comparison (Komai and Segonzac 2003), and this assumption does not contradict the phylogeny proposed by Shank *et al.* (1999). The new taxon exhibits a greater reduction of the rostrum than *Opaepele loihi* does, a condition similar to that found in the species of *Chorocaris* and *Rimicaris* (only in juveniles). The dorsal carina and teeth are completely absent and the tip of the rostrum is rounded or subtruncate in the new species. In *Opaepele loihi* the rostrum is weakly carinate dorsally and is usually armed with a dorsal row of minute denticles; the tip is acuminate.

The new species is rather conservative in having an acuminate antennal tooth and a pterygostomial tooth, in having marginally denticulate fourth and fifth pleonal pleura, and in lacking heavily plumose facial setae on the scaphognathite and the exopod of the first maxilliped. These characters are also seen in *Alvinocaris*, *Shinkaicaris*, *Opaepele*, and the outgroup *Bresilia*. In the species comprising *Chorocaris* and *Rimicaris*, the antennal tooth is blunt or obsolete; the fourth and fifth abdominal pleura are acutely or subacutely pointed only at their posteroventral angles and not marginally denticulate; and the scaphognathite and the exopod of the first maxilliped are covered with numerous long plumose setae. Thus, the new species is clearly excluded from the clade including *Chorocaris* and *Rimicaris*. In spite of the suggested relationship of the new species to this clade, we assign the new species to *Opaepele*, because of the high degree of similarity to its type species. At present, the establishment of a new genus for this new species seems to be premature. A full assessment of the generic status will be made after data from molecular analysis have become available.

Additionally, the new species appears distinctive among alvinocaridid species in having a rudimentary bud of the exopodal flagellum on the first maxilliped, even in adults. In most alvinocaridids the exopodal flagellum of the first maxilliped is completely reduced in adults (Komai and Segonzac 2003, 2004, 2005; personal observation). Only *Chorocaris paulexa* has a rudimentary flagellum bud on the first maxilliped (Martin and Shank 2005; personal observation). The ovigerous female of *Opaepele susannae* has a shallow depression ornamented by fine longitudinal striae on the carapace on either side of the midline. A similar condition is seen in ovigerous females of *C. paulexa*, *C. vandoverae*, and *Mirocaris fortunata*. The state of this character is unknown in *Opaepele loihi* because no ovigerous female of the species has been available for examination. Although assessment of intraspecific variation is not sufficient for certainty, the dactylus of the second pereopod seems to be proportionally longer in *O. susannae* than in *O. loihi* (about 2.0 times as long as the palm versus 1.1–1.2 times as long).

The type species of *Opaepele*, *O. loihi*, is so far known with certainty only from Loihi Seamount, Hawaii, but Komai and Segonzac (2005) reported the presence of an unidentified species of the genus from Minami-Ensei Knoll in the Okinawa Trough. The present new species is the first representative of *Opaepele* outside the Pacific Ocean, although it should be noted that the generic assignment is only provisional.

The following five alvinocaridid species were previously known from hydrothermal vents on the Mid-Atlantic Ridge (Martin and Haney 2005): *Alvinocaris*

*markensis* Williams, 1988, *A. williamsi* Shank and Martin, 2003, *Chorocaris chacei* (Williams and Rona, 1986), *Mirocaris fortunata*, and *Rimicaris exoculata*. The present new species is the sixth alvinocaridid known from the Mid-Atlantic Ridge, and the first of the genus *Opaepele*. In spite of extensive recent investigations at various hydrothermal vent sites on the northern Mid-Atlantic Ridge, this new species has not been encountered there. So far, *O. susannae* is restricted to the southern part of the Mid-Atlantic Ridge.

Genus *Rimicaris* Williams and Rona, 1986  
*Rimicaris exoculata* Williams and Rona, 1986

**Material examined.** ZMH K-41458, 1 female (CL 18.4 mm) and 1 ovigerous female (CL 19.4 mm), RV *Meteor*, M68/1 cruise, stn 7 ROV-2, ROV *Quest 4000*, Mephisto, southern Mid-Atlantic Ridge, 04°47.834'S, 12°22.593'W, 3045 m, wall of hot smoker, 11 May 2006.

**Distribution.** *Rimicaris exoculata* was heretofore known from hydrothermal vent fields on the northern Mid-Atlantic Ridge between 37°N and 13°N, including Snake Pit, TAG, Broken Spur, Lucky Strike, Logatchev, and Rainbow fields, at 1700–3650 m (Martin and Haney 2005); it is now newly recorded from the Mephisto field on the southern Mid-Atlantic Ridge, at 3045 m.

**Remarks.** The present specimens closely agree with the original description of *R. exoculata* (cf. Williams and Rona 1986) and material from various sites on the northern Mid-Atlantic Ridge (personal observation).

Genus *Mirocaris* Vereshchaka, 1997  
*Mirocaris fortunata* (Martin and Christiansen, 1995)

**Material examined.** ZMH K-41459, 1 female (CL 5.0 mm), RV *Meteor*, M64/1 cruise, stn 123 ROV-5, ROV *Quest 4000*, Turtle Pits, Southern Tower, southern Mid-Atlantic Ridge, 04°48.57'S, 12°22.41'W, 2922 m, wall of hot smoker, 11 April 2005; ZMH K-41460, 2 males (CL 5.3, 5.4 mm), RV *Meteor*, M64/1 cruise, stn 130 ROV-2, ROV *Quest 4000*, Turtle Pits, Two Boats, 04°48.57'S, 12°22.42'W, 2989 m, wall of hot smoker, 13 April 2005.

**Distribution.** *Mirocaris fortunata* was previously known from hydrothermal vents on the northern Mid-Atlantic Ridge between 38°N and 13°N, including Menez Gwen, Lucky Strike, Rainbow, Broken Spur, TAG, Snake Pit, and Logatchev, at 850–3480 m (Martin and Haney 2005); it is now recorded from Turtle Pits on the southern Mid-Atlantic Ridge, at 2922–2989 m.

**Remarks.** The present specimens closely agree with the redescription of *M. fortunata* given by Komai and Segonzac (2003). *Mirocaris fortunata* is superficially similar to *Opaepele susannae* sp. nov., *Chorocaris chacei*, and juveniles of *R. exoculata*, but it is immediately distinguished from these three species by the possession of strap-like epipods on the third maxilliped and the first to fourth pereopods.

### Acknowledgments

We are indebted to the chief scientist of Cruise M 68-1, Prof. Dr Andrea Koschinsky (International University Bremen, Germany), and the crew of RV *Meteor* and ROV *Quest 4000* for their competent work. We thank Prof. Dr Angelika Brandt (Zoological Institute and Zoological Museum, University of Hamburg, Germany) for allowing us to use the material described here, Anders Warén (Swedish Museum of Natural History, Stockholm, Sweden) for identification of gastropods, and Violaine Martin (Ifremer, Brest, France) for preparation of the map (Fig. 1). Sincere thanks are also extended to the two anonymous reviewers for making valuable suggestions for improvements of the manuscript. Participation of the second author in Cruise M68-1 was made possible by the financial support of Prof. Dr Colin Devey, coordinator of the German Research Foundation Special Research Project No 1144.

### References

- Haase, K. M., German, C. R., Petersen, S., Koschinsky, A., Seifert, R., Garbe-Schönberg, D., Parson, L. M., Giere, O., Kuever, J., Evans, A. J. and Strauss, H. In press. Exceptionally high-temperature venting associated with extensive fresh volcanism on the slow spreading Mid-Atlantic Ridge near 5°S. *Geology* 36.
- Kikuchi, T. and Hashimoto, J. 2000. Two new caridean shrimps of the family Alvinocarididae (Crustacea, Decapoda) from a hydrothermal field at the Minami-Ensei Knoll in the Mid-Okinawa Trough, Japan. *Species Diversity* 5: 135–148.
- Komai, T., Martin, J. W., Zala, K., Tsuchida, S. and Hashimoto, J. 2006. A new species of *Mirocaris* (Crustacea: Decapoda: Caridea: Alvinocarididae) associated with hydrothermal vents on the Central Indian Ridge, Indian Ocean. *Scientia Marina* 70: 109–119.
- Komai, T. and Segonzac, M. 2003. Review of the hydrothermal vent shrimp genus *Mirocaris*, redescription of *M. fortunata* and reassessment of the taxonomic status of the family Alvinocarididae (Crustacea: Decapoda: Caridea). *Cahiers de Biologie Marine* 44: 199–215.
- Komai, T. and Segonzac, M. 2004. A new genus and species of alvinocaridid shrimp (Crustacea: Decapoda: Caridea) from the North Fiji and Lau Basins, southwestern Pacific. *Journal of the Marine Biological Association of the United Kingdom* 84: 1179–1181.
- Komai, T. and Segonzac, M. 2005. A revision of the genus *Alvinocaris* Williams and Chace (Crustacea: Decapoda: Caridea: Alvinocarididae), with descriptions of a new genus and a new species of *Alvinocaris*. *Journal of Natural History* 39: 1111–1175.
- Komai, T., Shank, T. M. and Van Dover, C. 2005. A new species of *Alvinocaris* (Crustacea: Decapoda: Caridea: Alvinocarididae) and new record of *A. muricola* from methane seeps on the Blake Ridge Diapir, northwestern Atlantic. *Zootaxa* 1019: 27–42.
- Koschinsky, A., Billings, A., Devey, C., Dubilier, N. and Scientific Party. 2006. Discovery of new hydrothermal vents on the southern Mid-Atlantic Ridge (4°S–10°S) during cruise M 68/1. *InterRidge News* 15: 9–15.
- Martin, J. W. and Christiansen, J. C. 1995. A new species of the shrimp genus *Chorocaris* Martin and Hessler, 1990 (Crustacea, Decapoda, Bresiliidae) from hydrothermal vent fields along the Mid-Atlantic Ridge. *Proceedings of the Biological Society of Washington* 108: 220–227.
- Martin, J. W. and Haney, T. 2005. Decapod crustaceans from hydrothermal vents and cold



- seeps: a review through 2005. *Zoological Journal of the Linnean Society* 145: 445–522.
- Martin, J. W. and Shank, T. M. 2005. A new species of the shrimp genus *Chorocaris* (Decapoda: Caridea: Alvinocarididae) from hydrothermal vents in the eastern Pacific Ocean. *Proceedings of the Biological Society of Washington* 118: 183–198.
- Shank, T. M., Black, M. B., Halanych, K. M., Lutz, R. A. and Vrijenhoek, R. C. 1999. Miocene radiation of deep-sea hydrothermal vent shrimp (Caridea: Bresiliidae): evidence from mitochondrial cytochrome oxidase subunit I. *Molecular Phylogenetics and Evolution* 13: 244–254.
- Shank, T. M. and Martin, J. W. 2003. A new caridean shrimp of the family Alvinocarididae from thermal vents at Menez Gwen on the Mid-Atlantic Ridge. *Proceedings of the Biological Society of Washington* 116: 158–167.
- Vereshchaka, A. L. 1997. A new family for a deep-sea caridean shrimp from North Atlantic hydrothermal vents. *Journal of the Marine Biological Association of the United Kingdom* 77: 425–438.
- Watabe, H. and Hashimoto, J. 2002. A new species of the genus *Rimicaris* (Alvinocarididae: Caridea: Decapoda) from the active hydrothermal vent field, “Kairei Field,” on the Central Indian Ridge, the Indian Ocean. *Zoological Science* 19: 1167–1174.
- Webber, R. W. 2004. A new species of *Alvinocaris* (Crustacea: Decapoda: Alvinocarididae) and new records of alvinocaridids from hydrothermal vents north of New Zealand. *Zootaxa* 444: 1–26.
- Williams, A. B. and Dobbs, F. C. 1995. A new genus and species of caridean shrimp (Crustacea: Decapoda: Bresiliidae) from hydrothermal vents on Loihi Seamount, Hawaii. *Proceedings of the Biological Society of Washington* 108: 228–237.
- Williams, A. B. and Rona, P. 1986. Two new caridean shrimps (Bresiliidae) from a hydrothermal vent on the Mid-Atlantic Ridge. *Journal of Crustacean Biology* 6: 446–462.